Safe handling and transport of liquid nitrogen

Introduction

To ensure safety for you and your colleagues, and to gain access to the liquid nitrogen drain facility in the bamboo garden UNS50, reading this instruction supplemented by practical instructions from the Armico is mandatory. In case of questions or ambiguities surrounding these work instructions, please always consult the Armico or contact HSB.

Hazards and risks of liquid nitrogen

Normally, the oxygen concentration in the air we breathe is about 21% (v/v). Any reduction in the oxygen concentration below this 21% should be considered hazardous where precautions should be taken. The consequences of reduced oxygen concentration (with direct effect an increase in nitrogen concentration) are summarised in the table; Annex 1.

Liquid nitrogen is extremely cold (temperature: 196 °C), displaces oxygen in the ambient air, leads to embrittlement of contact surfaces and materials (especially carbon steel and plastics) and can build up pressure rapidly. In short: 3 main hazards that can lead to serious health risks if not used correctly.
Liquefied gases can cause severe frostbite on contact with the skin and/or eyes ('cold burn') due to their very low temperature. Inhaling cold gases can also cause lung damage.
Cold gases are heavier than air and mix poorly with ambient air. With insufficient ventilation, these gases can collect above the floor or accumulate in lower areas such as basements and wells. This can lead to high gas concentrations.

Suffocation is the main danger when exposed to a high gas concentration of nitrogen, because the high gas concentration of nitrogen leads to a reduction of oxygen concentration to very low levels (impoverishment of air). 1 litre of liquid nitrogen can be converted into 700 litres of gaseous nitrogen. An adverse property of nitrogen gas is that it is odourless, colourless and tasteless, and increased concentration is not noticed by the senses. When inhaling depleted air, a person can lose consciousness without warning and die of asphyxiation. Fellow workers trying to rescue the victim may suffer the same fate.

Safe working methods

Handling liquid nitrogen and personal protective equipment

- Make sure that hands and/or uncovered skin never come into contact with liquid nitrogen. So not even quickly fishing up an ep or cryotube from a Dewarvat! (A Dewar vessel is a small transport vessel for liquid nitrogen)
- Avoid contact with pipes (and other parts connected to them) through which liquid nitrogen runs. This could be pipes of the filling vessel, but also pipes and parts of equipment or systems cooled with liquid nitrogen.
- When draining liquid nitrogen from the drain vessel (bamboo garden), always wear loose-fitting and waterproof cold-insulating gloves and a face shield (cryogenic gloves and face shield present at the drain vessel). It is important that the cryogenic gloves are 'loose' so that they can be removed quickly in case of spillage. No gloves are worn during transport of a Dewar vessel containing liquid nitrogen liquid nitrogen in the laboratory should be worn laboratory gloves for the relevant application (e.g. snap-freeze).
- Even with cryogenic gloves on, it is not permitted to immerse these gloves in a vessel containing liquid nitrogen. Therefore, use (extended) auxiliary tools to remove materials or samples from liquid nitrogen and do so extremely carefully without spilling liquid nitrogen.
- Always wear closed shoes when working with nitrogen
- When transferring, pouring or other use of liquid nitrogen, always wear safety goggles or a face shield if there is a greater risk of splashing.
- Do not wear tight-fitting clothing, as this clothing must be able to be removed quickly in the event of an incident involving liquid nitrogen. Inside a laboratory, wear the appropriate laboratory coat. Make sure arms and legs are fully covered.

- If you or a colleague are directly involved in an incident involving liquid nitrogen, always consider your own safety and the safety of others first. If necessary, involve the FAFS (in-house First Aid Fire Safety) organisation (BHV in Dutch) by reporting the incident on the internal emergency number 1333 or via: 043-3875566.
- In case of incidents with nitrogen storage vessels combined with GMOs (most common incident: loose vials free in the nitrogen), the BVF (Biological Safety Officer) should always be contacted immediately regarding a health or environmental risk. Suitable materials to safely remove samples are available from the IDEE.

Dewar vessels

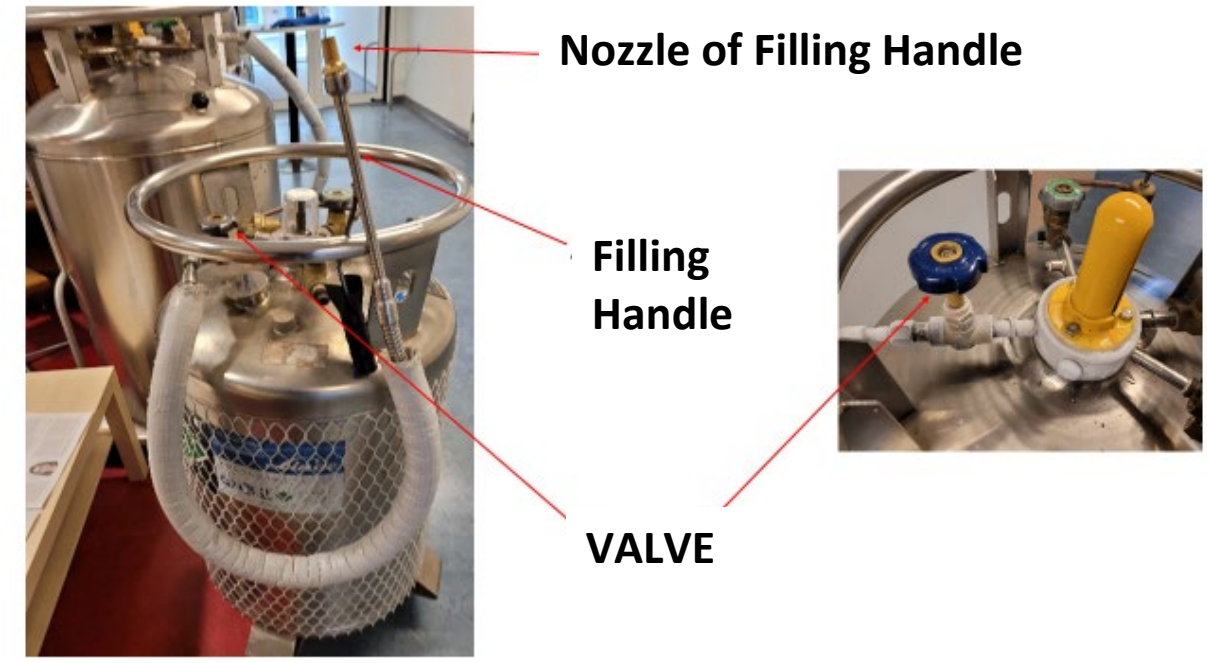
For filling and transporting liquid nitrogen, use only double-walled stainless steel Dewar vessels or insulating plastic vessels with a functional handle (Dewar vessels with a capacity of 2L and 4L are permitted). While using open Dewar vessels, ensure that evaporating liquid can always escape from the vessel. The lid of the vessel must not be clamped on the vessel to prevent pressure build-up in the vessel.

* Mark these Dewar barrels with the ‘low temperature’ danger label. 

Tapping liquid nitrogen

Draining of liquid nitrogen takes place in the draining facility in the bamboo garden UNS50. This area is only accessible with the UM smart card. Access with the smart card can be obtained through your department's Armico after taking note of these instructions.

- Before draining liquid nitrogen, wear the relevant personal protective equipment.
- Open your Dewar/transport vessel and carefully insert the nozzle of the filling handle into the transport vessel.
- Open the nitrogen line by gently opening the valve of the filling vessel.
- Fill the transport vessel to a maximum of 2/3 of its content with liquid nitrogen.
- Close the nitrogen line by gently closing the valve of the filling vessel. Then wait until no more liquid comes out of the filling handle and reattach the filling handle correctly to the filling vessel.
- Close the Dewar vessel by placing the lid loose on the vessel (i.e. do not clamp it). This is to prevent a ‘fountain’ of liquid nitrogen through overpressure valve in case the vessel falls over and pressure builds up.



Transport of liquid nitrogen

Transporting liquid nitrogen involves risks. For example, if a Dewar vessel falls over or is bumped, liquid nitrogen may be released unintentionally and potentially cause asphyxiation in small enclosed spaces (such as a lift). Vertical transport is allowed only by lift with oxygen detection without simultaneous passenger transport. In addition, Dewar vessels may also be transported vertically via the emergency stairwell on the north and south sides of the UNS50.

Transport and in particular vertical transport of transport drums **is not permitted via the open stairwells** in the north and south sides of the centre lobe UNS50.

Use of liquid nitrogen in laboratories

- As far as possible, avoid transferring liquid nitrogen from Dewar vessels.
- Transfer of liquid nitrogen on the laboratories from Dewar vessels in Styrofoam boxes is allowed, if the box is not damaged.
- After finishing the work, allow the remaining nitrogen in the Dewar vessel to evaporate in a room with adequate ventilation (at least 4-fold) or in the fume cupboard.
- After a Dewar vessel has (fallen over), always have it checked by the IDEE department for damage and for functionality of the pressure relief valve.

Accessing the liquid nitrogen drain facility

After reviewing this instruction, viewing with the Armico the liquid nitrogen filling facility in the bamboo garden UNS50, the transport route to the laboratories located in the department and the processes involving the use of liquid nitrogen within the laboratories, access to this filling facility can be obtained.

Both the employee and the Armico sign this instruction as 'complied'. The Armico then provides the following information to HSB:

1. Initials and name
2. Employee number
3. UM card number
4. Contract duration

HSB will provide the relevant details to UM-card to grant access for the relevant employee to the liquid nitrogen drain facility in the bamboo garden UNS50. HSB will also receive a signed copy of this instruction from the Armico by e-mail and will archive it. It is for the Armico to also store a signed copy of this instruction in the file of the relevant department.

Annex 1

Table 1: Effects of lowering oxygen concentration on the human body

Oxygen concentration (%)	Nitrogen concentration (%)	Effect(s) on human body
20,9	79	None: (Note: percentages are the natural shares of O2 and N2 in air).
18-21	80-82	Accelerated respiration.
11-18	82-87	Reduction in physical and intellectual performance without the victim's awareness. Breathing volume and pulse rate are increased.
8-11	87-90	Judgement and pain threshold are noticeably lowered. Possibility of fainting within a few minutes without prior warning. If the oxygen percentage falls below 11% there is a risk of death.
6-8	90-94	Nausea, weakness, negligent memory, unconsciousness. Fainting occurs after a short time. CPR is effective only if performed immediately.
0-6	>94	Gasping for breath and cramping with almost immediate fainting. Brain damage even if victim is rescued immediately.

Source: European Industrial Gases Association (EIGA) Safety Newsletter SAG NL N° 77/03/E

The employee below has read the instruction ‘Safe handling and transport of liquid nitrogen’ and followed the practical instruction

Department:

Employee name: Armico name:

PO number:

Card number:

Date: Date:

Signature: Signature:

Send signed page to info-hsb@maastrichtuniversity.nl